Vector Analysis Can Improve Predictability of Astigmatism

MELBOURNE—Cataract and refractive surgeons need to improve the predictability of their surgery's effects on astigmatism in order to improve the results of astigmatic surgery and address the amount of residual corneal astigmatism, says Noel Alpins, MD. Dr. Alpins, a refractive surgeon here, discussed with OPHTHALMOLOGY TIMES his work with astigmatism analysis and its potential to improve anterior segment surgery.

While both astigmatic keratotomy and photorefractive astigmatic keratectomy have the goal of reducing astigmatism, they approach the patient's astigmatism differently. Astigmatic keratotomy targets the steepest corneal axis, while photorefractive astigmatic keratectomy targets the refractive axis. "We should be reducing the contrasting differences between these two operations by operating according to the postoperative targeted astigmatism," Dr. Alpins said. "When there's a difference between the topography and the glasses, there's going to be an inevitable amount of astigmatism left in the system. We should address that residual astigmatism in each individual patient when planning the surgery, and deal with it in the optimal manner."

Although corneal topography gives ophthalmic surgeons valuable information after performing the surgery, it does not analyze the keratometric change when the astigmatic axis has changed, noted Dr. Alpins. "Some say that the change maps give you a vector analysis of the change in the cornea," he commented. "This is only true in two situations. In the first, the preoperative cornea is spherical, such as in a cataract patient with no astigmatism, and the surgery induces some postoperative astigmatism. In the second, the preoperative and postoperative astigmatism axes are absolutely aligned, and the arithmetic calculation is identical to the vector calculation.

"For the majority of change between preoperative and postoperative astigmatism, these two situations don't apply," he continued. "Most of the time, we see a change in the axis. When the axis of the astigmatism changes in the topography, only a vectorial analysis can determine what the surgically induced astigmatism is, and how it varies from the target induced astigmatism, or the amount of astigmatism you had to induce to achieve your goal."

Calculation Not Difficult

According to Dr. Alpins, such a calculation is relatively simple. In astigmatic keratotomy, for example, the surgeon places the transverse or arcuate cut on the steepest corneal axis shown by topography to target a spherical cornea, or zero astigmatism. "When we don't achieve zero astigmatism, the current topography machines don't provide a numerical analysis of the errors," Dr. Alpins stressed. "They don't provide the ability to determine the magnitude of error, whether we operated on the desired amount of astigmatism, whether we hit it too hard or not hard enough. They don't tell us whether we placed the incision in the right axis, or off axis, or how many degrees off axis that incision was placed."

"We have to be able to determine the magnitude of error and the angle of error," he continued. "Then the topography can be used to tell us what trends and patterns have occurred, and how we can improve our surgeries. Perhaps you have placed all the incisions an average of 5° off in a clockwise direction. You can then identify the problem if there is a system error, or correct it by adjusting your incision by 5° in a subsequent operation. We have to know this to be able to improve our astigmatism surgery."

In photorefractive astigmatic keratectomy, the use of the refractive axis itself limits the surgery's effectiveness, said Dr. Alpins. "When we're targeting zero spectacle astigmatism, the excimer laser machine is effectively sculpting a lens on the surface of the eye," he said. "That lens is identical to the glasses adjusted to the corneal plane. You have an inevitable amount of astigmatism being sculpted onto that cornea when the corneal and refractive astigmatism are not identical. We have to be able to calculate our targeted corneal astigmatism to what we're expecting prior to surgery. When you measure what you've actually achieved, you can then determine your errors. If you don't know where you're targeting, how do you know how much you're off?"

Standard Needed

Refractive and cataract surgeons need an objective standard in order to compare their surgery's astigmatism results, Dr. Alpins said. "If everyone uses the same standard, then we'll be able to compare techniques and further improve our surgery," he emphasized. "We've got corneal topography, which is becoming a standard, and yet we have been unable to achieve its fullest potential by taking the data out of that machine, analyzing them, and getting a vectorial analysis. Preoperative astigmatism analysis could reconcile the two approaches of astigmatic keratotomy and photorefractive astigmatic keratectomy and improve the results of both surgeries." Such analysis could also help optimize refractive and keratometric astigmatism in refractive cataract surgery, he added, to bring all refractive surgery within the realm of a common principle.

Dr. Alpins developed the Alpins Statistical System for Ophthalmic Refractive Surgery Techniques (ASSORT), a computer software program for astigmatism analysis. He has a financial interest in this product.

—Paula Moyer
Contributing Editor